State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

WISCONSIN
DEPT. OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary

101 S. Webster St.
Box 7921
Madison, Wisconsin 53707-7921
Telephone 608-266-2621
FAX 608-267-3579
TTY 608-267-6897

SHORELAND SETBACKS AND BUFFERS

Summary of Related Research

Introduction

Setting structures back from the edges of lakes, rivers and wetlands creates a buffer that can help mitigate the environmental impact of a structure and the surrounding development. The vegetation of buffers, including native trees, shrubs, wildflowers, and grasses, helps to protect water quality, prevent flooding, provide fish and wildlife habitat, and can screen neighboring properties to ensure greater privacy and natural scenic beauty.

Current minimum standards in chapter NR 115 require structures to be setback 75 feet from the ordinary high water mark. Within that setback, the first 35 feet, from the ordinary high water mark of navigable waters to 35 feet inland, was intended to provide a primary buffer. The primary buffer was intended to perform most buffer functions, so state laws are more protective of this important area than that of the secondary buffer, which encompasses the area 35 feet to 75 feet inland. The secondary buffer has a limited capacity to perform buffer functions, but is intended to allow property owners an area for lawn and other traditional landscaping features. The effectiveness of any buffer depends on several factors including its size, vegetation, slope, soil, adjacent land uses, surface water flow patterns and other factors. The initial design and long-term maintenance of the buffer also affect how well it works.

The primary and secondary buffer are intended to perform several functions, but they can be broadly defined as protecting water quality, providing wildlife habitat, and preserving the natural beauty of Wisconsin's shorelands. Specifically, s. 281.31(1), Wis. Stats., requires that:

"*. . . (t)he purposes of the regulations shall be to further the maintenance of safe and healthful conditions; prevent and control water pollution; protect spawning grounds, fish and aquatic life; control building sites, placement of structure and land uses and reserve shore cover and natural beauty.*"

The remainder of this document will look in more detail at the three main functions of shoreland buffers and factor affecting those functions.

Water Quality

There is no such thing as chemically pure water in nature. In nature, water quality can vary with climate, watershed mineralogy, and materials carried in with precipitation and runoff. As landscapes shift from a "natural" state to a "developed" state, the rain and runoff can carry oils, bacteria, litter, sediment, fertilizers, and foreign chemicals from streets, parking lots, lawns, dumpster pads, and metal roofs. Some 70% of the water pollution in the United States comes from these "nonpoint" sources: the sediment, oils and chemicals that runoff carries from eroding soil, parking lots, and intensely maintained lawns.[1] Table 1 summarizes common materials in natural and developed watershed and their roles.

Table 1. Some of the Constituents of Surface Waters.[1]

Constituent	Source in Nature	Role in Natural Ecosystem	Source of Developed Area Excess	Role of Excess
Sediment	Banks of meandering channels and shorelines	Maintain stream profile and energy gradient; store nutrients	Construction sites; eroding banks	Abrade fish gills; carry excess nitrients and chemical in absorption; block sunlight; cover gravel bottom habitats
Organic Compounds	Decomposing organic matter	Store nutrients	Car oil; herbicides; pesticides; fertilizers	Deprive water of oxygen by decomposition
Nutrients	Decomposing organic matter	Support ecosystems	Organic compounds; organic litter; fertilizers; food waste; sewage	Unbalance ecosystems; produce algae blooms; deprive water of oxygen by decomposition
Trace Metals	Mineral weathering	Support ecosystems	Cars; construction materials; all kinds of foreign chemicals	Reduce resistance to disease; reduce reproductive capacity; alter behavior
Chloride	Mineral weathering	Support ecosystems	Pavement deicing salts	Sterilize soil and reduce biotic growth
Bacteria	Native animals	Participate in ecosystems	Pet animals; dumpsters; trash handling areas	Cause risk of disease
Oil	Decomposing organic matter	Store nutrients	Cars	Deoxygenate water

Sediment

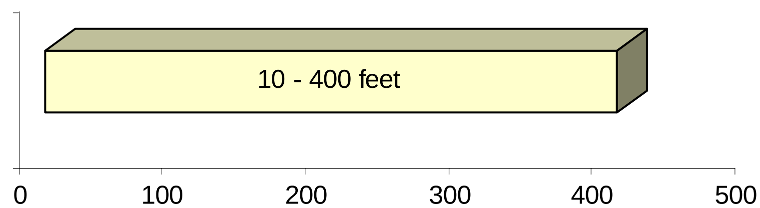
In a natural system, sediment from gradually meandering stream banks and shorelines builds point bars and aquatic habitats. In developed areas, excess sediment comes from eroding construction sites and from excessively eroding banks. Additional materials may come from glass, asphalt, stone, rubber, rust, and pavement fragments. When suspended in water, excess sediments makes the water turbid, inhibiting plant growth and reducing species diversity. When the excess sediment settles to the bottom, the sediment destroys spawning beds and the habitats of bottom-dwelling biota that depend on sand and gravel particles and their voids for habitat.[1] When there are extremely high concentrations of fine suspended sediments, it can even cause the direct mortality of many fish.[2]

Buffers can reduce sedimentation in a variety ways, including:

- By displacing sediment-producing activities away from surface waters (setbacks),
- By reducing the velocity of sediment-bearing runoff, allowing sediments to settle out of the runoff and be deposited in the buffer,
- By stabilizing banks, preventing shoreline erosion, and
- By moderating water flow, reducing bed scour.[2]

Recommended buffer depths for removing sediments can vary quite a bit. While some studies have found that buffers as narrow as 15 feet can be fairly effective in the short-term, more long-term studies suggest the need for wider buffers, especially for greater sediment control on steeper slopes. For a bare minimum buffer depth, 30 feet is suggested, but a 100-foot deep buffer is sufficiently large enough to trap sediment under most circumstances and should maintain a healthy biota.[2]

Table 2. Recommended Buffer Depths for Sediment Control (based on 7 studies).[3]



Buffer depth recommendations vary because simply put, all buffers are not the same. Each, as part of a living system, functions differently and the characteristics of the buffer will affect its functional capacity. Some factors that influence the effectiveness of a buffer to protect water quality include:

- Soil type – less erodible soils within a buffer pose less risk of channeling from excess runoff. More permeable soils allow more infiltration of rain and snow melt into the ground.
- Vegetation type and density – Woody plants at a natural density generally do the best job of holding soil in place within buffers. They also contribute to buffer stability by intercepting rain and snow (approximately 20% in the northeastern United States, depending on species) and reducing sunlight penetration, thereby moderating snow melt that often precedes peak runoff times.
- Surface roughness of land – An undisturbed landscape retains its ability to trap surface water through ponding and groundwater infiltration.
- Season – In northern areas, buffer effectiveness can be reduced during times of the year when the ground is frozen and plants are dormant.
- Nature of the land beyond the buffer – Buffers have their limits as to how much runoff or pollutants they can absorb. The more intense the land land use above a buffer, the more likely the buffer is to have its assimilative capacity exceeded.[4]

Organic Compounds

In nature, organic compounds come from the decomposition of naturally occurring organic matter, like leaves. In developed areas, excess organic compounds result from petroleum products that are "organic" in a chemical sense. Excess organic decomposition deoxygenates water and weakens biotic communities in streams and lake, and oil can blanket the water surface, preventing reaeration.[1]

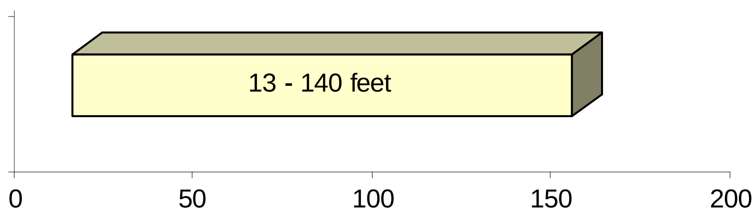
Please refer to the discussion in the above sediment section to learn more about how buffers function and factors influencing the effectiveness of buffers.

Nutrients
In a natural system, nutrients, such as phosphorus and nitrogen, come from the organic detritus of shoreland vegetation and support aquatic ecosystems. In developed areas, excess nutrients come from fertilizers on intensely maintained landscapes, septic systems, sewer leaks and overflows, and leachates and debris from dumpsters and trash handling areas. Aquatic communities that adapt to excess nutrients are generally of low diversity, commonly dominated by a few species of algae. The decomposition of the excess algae can also further deprive the water of oxygen.[1]

Buffers can reduce the amount of nutrients flowing into surface waters in a number of ways, depending on the nutrient. Phosphorus is usually attached to sediment, so buffers that can sufficiently remove sediments should also trap phosphorus. While it is possible for a buffer to become "saturated" with phosphorus, buffers can still regulate the flow of phosphorus from the land into surface waters.[2]

Nitrogen removal, while not thoroughly understood, is accomplished primarily through uptake by vegetation and denitrification. Denitrification is the conversion of nitrate into nitrogen gas by anaerobic microorganisms. Denitrification results in a permanent removal of nitrogen from shorelands and is likely the dominant mechanism for nitrogen reduction in many shoreland systems. Unlike phosphorus, nitrate is quite soluble and readily moves into shallow groundwater. The amount of nitrogen reduction will depend on groundwater flows. If the flow is shallow and passes through the root zone of shoreland vegetation, the vegetative uptake and denitrification can be significant. If the flow bypasses the shoreland zone and recharges an aquifer or contributes to the base flow of a lake or river, nitrogen loss may be much less.[2]

Table 3. Recommended Buffer Depths for Nutrient Control (based on 8 studies).[3]



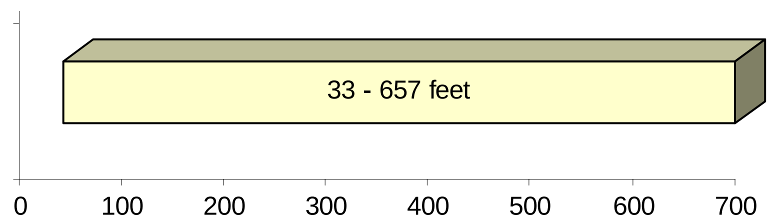
As runoff passes through naturally vegetated buffers, at least a portion of sediment, phosphorus, and nitrogen from runoff is removed. The amount of pollutants removed depends on pollutant load, the nature of the material, the amount of runoff, and the character of the buffer. The removal of pollutants is generally not a linear relationship with buffer depth, but decreases with increasing buffer depth. For instance, more pollutant removal occurs in the first 100 feet than the second hundred.[4] For more information on factors impacting nutrient removal, please refer to the discussion in the sediment section.

Wildlife Habitat

Shoreland buffers provide wildlife habitat by offering foraging and nesting habitat as well as cover for a mix of upland, aquatic and wetland species. Shoreland buffers can also serve as travel corridors for migratory and nomadic, as well as resident, species. Buffers protect surface waters and wetlands from temperature fluctuations, which can affect a river's capacity to hold oxygen. The leaf litter and woody debris from buffers along smaller streams supply most of the energy utilized by creatures within the stream. Woody debris also traps leaf litter, making it available to organisms over a long period of time. Shoreland buffers also help stabilize banks, and naturally undercut areas beneath tree roots offer cover for fish, turtles, and other creatures.[4]

Buffer depth recommendations vary with the species of concern. The ability of a shoreland buffer to support wildlife is usually directly related to its depth. Narrow buffers may support a limited number of species, while larger buffers of at least 300 feet may be required to maintain populations of riparian-dependent interior species. To provide optimal habitat, native vegetation should be maintained or restored in buffers as well.[2]

Table 4. Recommended Buffer Depths for Wildlife Habitat (based on 15 studies).[3]



Many factors influence the capacity of a buffer to provide wildlife habitat. Several major factors include:

- Landscape position – Buffers can function as both resident ("in-place") habitat and as travel routes for wildlife. As resident habitat, a buffer's value is supplemented by other habitats to which is it connected. This is important because larger habitat blocks are known to support greater diversity than smaller ones.
- Integrity of the buffer – When buffers become fragmented, the effects can include direct mortality (roadkill), modification of animal behavior, alteration of physical or chemical environments, and introduction of exotic species. The effects of buffer fragmentation can extend into aquatic and wetland habitats by altering hydrology, increasing sedimentation, and introducing pollutants.
- Edge effects – When buffers become fragmented strips between land and water, they may be subject to negative edge effects of predation and parasitism, as well as physical effects such as wind, drying, temperature increase, and blowdown of trees. Edge habitats tend to harbor disproportionate populations of predators such as blue jays, crows, raccoons, skunks, red foxes, and dogs and cats. A "soft" edge that has a gradual transition into upland areas may

reduce the negative edge effects. Essentially this means providing a transitional upland buffer to support the shoreland buffer habitat functions more fully.

- Vegetation type – The species of plants in an area generally determine the animals that will occupy an area. Dense stands of evergreen trees, for example, are known for their value as deer wintering areas, and nut-producing trees, such as oak and hickory, provide food for a number of species, including bear, deer, turkey, and squirrels.
- Habitat structure – The structure provided by a shoreland determines which species can use the habitat. Habitat structure includes:
  - Horizontal diversity
  - Vertical diversity
  - Soil qualities
  - Dead standing trees
  - Downed logs
  - Rocks, boulders, cliffs[4]

However desirable they are, 300-foot or wider buffers are not practical on all lakes and rivers. Minimum shoreland buffers may be better based on water quality and aquatic habitat functions. This should result in narrow riparian corridors that can offer good habitat for many animal species. For these narrower buffers to succeed as wildlife habitat, however, it will be important for buffer management provisions to preserve the vegetation and habitat structure needed by wildlife.

Natural Beauty

Shoreland buffers also fill another important function that is often taken for granted – natural scenic beauty. The aesthetics of a shoreline may be an intangible concept, but many people often recognize when it has been degraded or lost. In a Minnesota survey, waterfront property owners and lake users cited cabin and home development over 85% of the time as the cause when they perceived a decline in the scenic quality on the lake they used the most. Other activities at the top list that resulted in a decline in scenic quality included installation of docks and boat lifts, and removal of trees and shrubs in the shoreland area.[5]

These man-made elements are often seen as visual intrusions in a natural setting – they “grab” our attention and interrupt or upset the natural character of a setting. In general, landscape aesthetic assessment literature has found that more natural scenes, those in which human presence or activities are relatively less visually apparent, are consistently preferred over scenes where human development is more obvious.[6]

It is possible however to reduce the obvious nature of man-made elements, especially those which may be prominently located. The contrast between natural and man-made elements can be reduced in a variety of ways, including:

- changing the color to camouflage the structure,
- reducing gloss or reflectivity,
- planting trees and shrubs to screen and shade the structure,
- reducing movement and activity near the element (e.g. flags, wind socks, lanterns, etc.),
- softening highly visible angularities or structural complexity,
- removing structural elements from ridge lines to reduce the contrast of silhouettes,

- adapting structural forms which reflect the local terrain,
- reducing artificial lighting, and
- keeping clearings and land disturbances to a minimum.[7]

Maintaining or restoring a shoreland buffer can help preserve the natural beauty of shorelands by screening structures from the view of people on or across the water. The depth of a buffer required to screen structures will depend on the location and height of the structure, the slope of the site, and the vegetation in the buffer.

Literature Cited

[1]Ferguson, B. K. 1998. *Introduction to Stormwater: Concept, Purpose, Design*, New York: John Wiley & Sons, Inc.

[2]Wenger, S. 1999. *A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation.* Athens, GA: Office of Public Service and Outreach, Institute of Ecology, University of Georgia. http://outreach.ecology.uga.edu/tools/buffers/lit_review.pdf

3Johnson, A.W. and D. M. Ryba. 1992. *A Literature Review of Recommended Buffer Widths to Maintain Various Functions of Stream Riparian Areas*. King County Surface Water Division.

[4]France, R. L., ed. 2002. *Handbook of Water Sensitive Planning and Design*. New York: Lewis Publishers.

[5]Anderson, K. A., T.L Kelly, R. M. Sushak, C.A. Hagley, D.A. Jensen, G. M. Kreag. 1999. Summary Report on Public Perception of the Impacts, Use, and Future of Minnesota Lakes: Results of the 1998 Minnesota Lakes Survey. A joint publication by the University of Minnesota Sea Grant Program (SH 1) and Minnesota Department of Natural Resources, Office of Management and Budget Services.

[6]Bernthal, T. W. 1997. *Effectiveness of Shoreland Zoning Standards to Meet Statutory Objectives: A Literature Review with Policy Implications*. Madison, WI: Wisconsin Department of Natural Resources.

[7]Litton, R., R. Tetlow, J. Sorenson and R. Beatty. 1974. *Water and landscape: an aesthetic overview of the role of water in the landscape.* Port Washington, NY: Water Information Center, Inc.